AD-A055 907 ARMY TEST AND EVALUATION COMMAND ABERDEEN PROVING GRO--ETC F/G 13/4
CONTAINER HANDLING AND ACCESSORY EQUIPMENT.(U)
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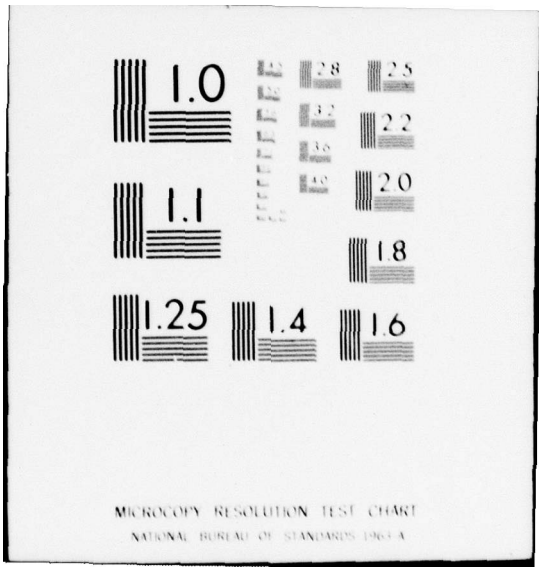
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REPORT DOCUMENTATION PAGE

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Container Handling
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Describes a method for test and evaluation of handling and accessory equipment for oversized cargo containers. It discusses test planning, preparations for test, inspection, technical performance, beach mobility, logistics-over-the-shore, terminals handling operations, restraint system tests, spreader, sling, and pendant tests. Applicable to transporters, truck/tractors, trailers, container handlers, container stuffers, spreader bars, slings and pendants, internal cargo restraint systems, and special devices such as hoppers and powered taglines.

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(9) Test operations procedure.

U. S. ARMY TEST AND EVALUATION COMMAND
DEVELOPMENT TEST II (EP) - SYSTEM TEST OPERATIONS PROCEDURES.

AMSTE-RP-702-109 (14) TOP
Test Operations Procedure 10-2-215 (12) 23 P. (11) 31 Mar 1978
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(6) CONTAINER HANDLING AND ACCESSORY EQUIPMENT

SECTION I
GENERAL

1. Purpose and Scope. This TOP provides guidance for planning tests and for evaluating the operational and performance characteristics of container handling and accessory equipment. Equipment covered includes container transporters, container materials handling equipment (MHE) and cranes, slings and spreader bars, chassis adapters, tractor-trailers, ramps, hoppers, platform decks, conveyors, roller systems, and similar materiel. Test objectives are to determine the conformance of the test item with the ROC, DP, or other suitability criteria. The scope of testing will be selected from sections II and III to satisfy the requirements for the particular test item and test type. For DT II (engineering phase) tests the scope will depend upon the criteria stated in the governing requirements documents. For DT III (initial production) tests,

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the scope will be in accordance with the contractual provisions of the applicable military specification and suitability criteria as established by the test directive. This TOP is a basic guide for preparing actual test plans, and procedures may require modification to suit special items.

2. Background. The oversize and overweight nature of containers has generated the need for many new materials handling media. Army standard forklifts (10,000-pound capacity) suffice for handling the CONEX container. Increased capacity and weights of the containers (to 67,200 pounds for the 40-foot unit) has spurred the development of high capacity MHE; toplifting, sideloading, and straddle carriers; tilt-bed and self-loading transporters; and various special dock and ramp configurations.

a. Specific items of handling and accessory equipment include:

(1) Transporters. Designed to carry containers only or both container and breakbulk cargo, yard or military types; 22-1/2-ton capabity (to carry up to 20-foot containers) or 34-ton (to carry up to 40-foot containers).

(2) Truck Tractors. Designed to haul any of the transporters cited above including both military (such as the M52) and modified commercial designs.

(3) Trailers. Including special end-loading or tilt-bed types, or modified standard types (such as the M127).

(4) Container Handlers. Diesel-powered, 4-wheel-drive, articulated-steer vehicles, capable of rough terrain operation with fork- or toplift attachments, and capacities to 50,000 pounds or more; may include sideloaders or straddle-carry types.

(5) Container Stuffers. Low profile, 4-wheel-drive vehicles, relatively small capacity (such as 2500 pounds), capable of entering and maneuvering inside containers.

(6) Spreader Bars. Structural toplifting frames, with twistlock attachments for containers and eyes for sling attachment, with or without guides, manual or automatic aligning and locking.

(7) Slings and Pendants. Various types: steel and nylon, single or multileg, for marine or helicopter use, some standard and some made up, with appropriate end fittings, in different lengths and capacities.

(8) Internal Cargo Restraint Systems. Various mechanical or pneumatic dunnage devices, tracks, beams, eyes, etc., for tiedown and restraint of cargo within containers.

(9) Special Devices. Equipment designed to achieve special functions, such as powered taglines to dampen pendulation of slung containers, chassis adapters such as for mounting AF 463L pallets to MILVAN chassis, railcar shock damper for cushioning containers loaded on railcars, hopper devices for aligning and guiding containers into a hatch or cargo bed, and vehicular mounted mobile ramping devices.

b. Some general characteristics of accessory equipment which should be considered in planning tests are:

(1) Equipment must be compatible for use with the standard family of ANSI/ISO intermodal cargo containers. (For description of these containers, see TOP 10-2-214.)

(2) Transporters should carry combinations to 40 feet long, 8 feet wide, 8-1/2 feet high, and weights to 67,200 pounds, or lesser combinations as dictated by requirements, such as to 20-foot length and 44,800-pound weight for the MILVAN container.

(3) Locking devices for attachment to containers, whether for cargo bed attachment or for lifting, shall conform dimensionally, strengthwise, and by spacing to requirements as established in ANSI MH 5.1.

(4) Transported configurations in general shall not present restrictions to side or end openings of containers or access to forklift tine pockets or lifting points.

(5) Kingpin heights and capacities of commercial and military interchangeable truck tractors and transporter-trailers must be compatible (ref. 5, appendix).

(6) Electrical and brake systems of transporter-trailers and their prime movers must be compatible.

(7) For transported containers, the worst condition of loading is assumed to be a fully loaded container with center of gravity at midheight.

(8) For purposes of stability, most carriers (trucks, trailers, sideloaders, etc.) present the short axis of the container to tipping situations on side slopes; forklifts, however, present the long axis under such conditions.

(9) Container handling and accessory equipment is designed to meet the requirements of the Engineering for Transportability Program as stated in AR 70-44 and AR 70-47.

c. This TOP has been prepared as part of a study described in reference 16 (appendix).

3. Equipment and Facilities. In addition to equipment and facilities defined in the documents listed in section II, special facilities related to containers handling and testing are described in appendix E to TOP 10-2-214.

SECTION II
TEST PROCEDURES

4. Supporting Tests. TOP's/MTP's, military standards and specifications, tests defined in section III, and other published documents to be considered in formulating a test plan are shown for respective types of equipment on the following list.

TEST SUBJECT TITLE	PUBLICATION NO.[a]			
	Transporters	Container Handlers	Slings & Spreader Bars	General Test Requirements
a. Initial Inspection (refer to para 7)	2-2-505 2-2-802	2-2-505		
b. Physical Characteristics	2-2-500 2-2-501 2-2-800 2-2-801	2-2-500	1-2-504 3-2-806 3-2-807	1-2-504
c. Preliminary Operation (refer to para 6)	2-2-505	2-2-505		
d. Safety	2-2-508	2-2-508	MIL-STD-882	10-2-508
e. Technical Characteristics (refer to paras 8, 12, 13)	2-2-602 2-2-604 2-2-608 2-2-610 2-2-611 2-2-612	9-2-155 2-2-703 2-2-608 2-2-610 SAE J810 MIL-STD-448	9-2-202	2-1-001 10-2-214
f. Operational Performance (refer to paras 9, 10, 11)	2-2-616 2-2-020	2-2-106 9-2-064 MIL-STD-448 2-2-610 2-2-619 2-2-613	9-2-202	1-1-011

[a]For TOP/MTP titles see TECOM Pam 310-4 (ref. 4, appendix).

TEST SUBJECT TITLE	PUBLICATION NO.[a]			
	Transporters	Container Handlers	Slings & Spreader Bars	General Test Requirements
g. Environmental Tests	2-2-808	2-2-815 [b]2-2-816		AR 70-38 MIL-STD-810 1-1-050 2-1-006
h. Electromagnetic Interference	2-2-613	2-2-613		6-2-542 MIL-STD-461 MIL-STD-462
i. Transportability				1-2-500
j. Human Factors	2-2-803	2-2-803	10-2-505 9-2-202	MIL-STD-1472
k. Reliability				1-2-503
l. Endurance	2-2-506	2-2-506	9-2-503	1-2-502
m. Maintenance Evaluation	2-2-503	10-2-507	10-2-507	TECOM Suppl 1 to AR 750-1

[a]For TOP/MTP titles see TECOM Pam 310-4 (ref. 4, appendix).
[b]When published.

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Test Planning.

a. DT II (engineering phase) test planning requires review of test guidance literature, familiarization with preceding development and test phases, study of test criteria, and selection of appropriate samples, methods, sequence, facilities, and test equipment. Standards for the test phases outlined in this section are given in the applicable ROC or test directive as indicated in paragraph 1. Risk/cost and safety provisions must be given prime consideration. Data from previous and similar tests should be considered in order to avoid duplication and reduce the scope of further testing.

Background documents for the applicable category of equipment (such as TOP/MTP 2-1-001 for vehicles or TOP 1-1-045 for general equipment) should be consulted. TOP 10-2-214 and Report APG-MT-4459 (ref. 16, appendix) are pertinent reference documents.

b. Each accessory item, especially one of commercial nature, presents unique test requirements based on its particular function and mission. Procedures of documents cited in section II must be considered and adapted accordingly. In preparing detailed test plans, advantage should be taken of the cycle performance phases, such as those in paragraphs 9, 10, and 11, to compile the performance experience needed for such subtests as reliability, endurance, and maintenance evaluation.

6. Preparation for Test. Test preparations include the selection of appropriate test facilities, arrangement for support, review of the safety statement from the developer, and the selection and training of the test team which may involve attendance at new equipment training courses. Adequate leadtime should be planned in view of the extensive support and training required for some items. Limitations as to which containers can be handled should be noted. Maintaining stability is a prime factor in container handling, and the crane handling environment is critical for both personnel and cargo from the human factors and safety aspects.

7. Inspection. The initial inspection is conducted in a sequence that will insure that data, photographs, and damage assessment are obtained on the equipment as initially delivered, transported, crated or cradled; followed by inventory, technical inspection, assembly, and functional checkout, as appropriate. Care is taken to obtain dimensions, weights, cubages, and component data required before unpacking or assembly. During the detailed inventory and inspection, note should be made of the use of standard components and accessories as may be required by the ROC/DP. Adequacy of the technical literature provided for training and servicing on receipt should be noted.

8. Technical Performance. (NOTE: This test is typical for a container handling forklift.)

8.1 Objective. To determine whether the test item meets the specified technical performance requirements.

8.2 Standards. Criteria from the applicable ROC/DP or other requirements authority will apply.

8.3 Method. Procedures such as the following are used.

a. Physical Characteristics. Fork tine reach below ground level and maximum lift height, mast oscillation, side shift capability, mast tilt, tine length, and overall dimensions of the top lift attachment, expanded and in a contracted position, are measured using calibrated measuring devices and clinometers.

b. Acceleration and Maximum Speed. Tests are conducted on a level, paved road using a calibrated timing device and stopwatches to determine the time required to accelerate from a standstill to 15 mph (and to 20 mph without mast and counterweights) in both forward and reverse directions. Testing is accomplished with the rated load except when testing to the 20-mph criterion. DF-2 fuel is used.

c. Slope Stability. Slope stability tests are conducted on earthen slopes, 25% longitudinal and side slope up to 15%, with a rated load in the load carrying position and with no load. Stability checks are made ascending and descending the longitudinal slope and traversing the side slope in both directions. Side slope testing also includes operation with rated load centered then shifted to the extreme right and left of center using the side shift capability to evaluate the effects of unequal load distribution. Full turns on the side slope in both the clockwise and counterclockwise directions are made to evaluate maneuverability and stability under maximum steering conditions.

d. Turning Radius. The minimum turning radius is measured using a calibrated measuring device.

e. Lift Speed. Lift speed is measured with no load in the load carrying attachment using a calibrated timing device.

f. Refueling Rate. The rate at which the forklift truck will accept fuel is measured using a fuel rate meter.

g. Transportability. Evaluations are made to determine:

(1) Whether the forklift can be transported by the modes of transport established in the ROC or DP. This may be accomplished either by comparison of the item's characteristics with transportability criteria for the individual modes or by test loadings. If air shipment is required, an air transportability analysis or test loading will be requested in accordance with the procedure in AR 70-44, appendix B.

(2) Whether the forklift can be transported by recovery type trailers. The forklift is loaded on a recovery trailer and transported 50 miles over the APG Churchville hilly cross-country trailer course (TOP 1-1-011) or equivalent. Any compatibility problems between the forklift and trailer and any difficulty encountered by the prime mover in negotiating the hilly cross-country course are noted.

h. Materials Handling. A compatibility evaluation is made to determine whether the forklift can adequately handle the 8-foot-wide family of military and commercial containers and 8- by 20-foot ISO/MILVAN containers weighing up to 44,800 pounds. Containers are placed in the load carrying position, and any dimensional incongruities are noted and measured. The time required to adjust the expandable top lift attachment from 10 to 40 feet is measured with a calibrated stopwatch.

i. Stopping Distance. Stopping distance testing is conducted on a level paved road using a fifth wheel and calibrated timing device. Distances required to bring the vehicle to a complete stop from speeds of 5, 10, and 15 mph are measured. Vehicle drift in terms of feet per 100 feet is also measured.

j. Steering Effort. With the vehicle stopped and the engine idling, the effort in pound-feet (torque) to steer the vehicle in both directions is measured using a calibrated steering wheel torque measuring device.

8.4 Data Required.

a. Fork tine reach below ground level (inches ±0.1 inch).

b. Mast oscillation, roll (degrees ±0.1°).

c. Load side shift (inches ±0.1 inch).

d. Lift speed (fpm ±0.5 fpm).

e. Mast tilt (degrees ±0.1°).

f. Container handler adjustment (feet ±0.1 foot).

g. Time to fully extend and contract container handler (minutes ±0.1 minute).

h. Vehicular turning radius (feet ±0.2 foot).

i. Vehicular speed (mph ±0.2 mph).

j. Refueling rate (gpm ±0.5 gpm).

k. Any difficulty encountered in negotiating earthen longitudinal and side slopes.

l. Any stability problems when operating on earthen longitudinal and side slopes.

m. Any mode of transportation for which special permits, routing, or procedures are required. Types of recovery trailers that can transport the test item, any adjustments needed before transporting the test item on an open highway, and loading and securing procedures will be documented in sufficient detail to meet requirements for the publication of transportability guidance (AR 70-47) or requirements for training literature (AR 310-3).

n. Any forklift dimensional problems encountered in handling the 8-foot-wide family of military and commercial containers and 8- by 20-foot ISO/MILVAN containers weighing up to 44,800 pounds.

8.5 Analytical Plan. The analytical plan includes objectively comparing the data with the stated requirements and presenting the results in tabular form with a narrative discussion pertaining to the degree of conformance with the stated criteria.

9. Beach Mobility.

9.1 Objective. To determine whether the test item possesses sufficient mobility to handle containers within a beach environment.

9.2 Standards. As specified in ROC/DP or other requirements authority.

9.3 Method. Procedures are described in TOP 1-2-510. A container handling forklift typically is subjected to 10 test cycles on the mobility course (fig. 3, TOP 1-2-510) or 10 hours of operation, whichever occurs first. Upon completion of the beach mobility operations, the test item simulates operations that would occur in a forward storage area.

9.4 Data Required. Collected data will include description of environmental and terrain conditions, soil description (moisture content, profile, trafficability and mobility indices), load types and weights, number of course traversals and times to traverse, observation of vehicle stability and performance factors, and description of failures and incidents.

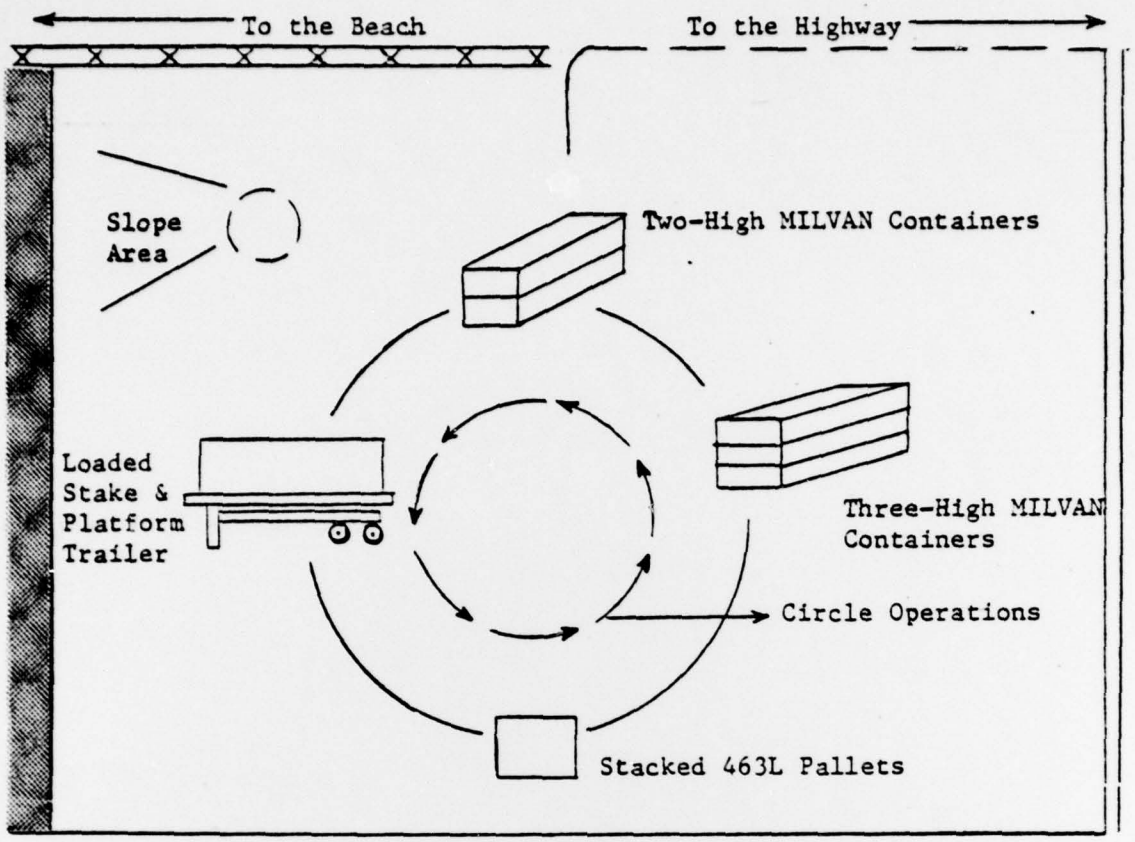
9.5 Analytical Plan. Data are tabulated and analyzed to assess the capability of the test item to satisfactorily perform and negotiate the test course without degradation of operational capability, malfunction, or damage.

10. Terminals Handling Operations. (NOTE: This test is typical for a container handling forklift.)

10.1 Objective. To determine the capability of the forklift to handle containers in a simulated storage and terminals handling environment.

10.2 Standards. As specified in the ROC/DP or other requirements authority.

10.3 Method. The test item is required to perform simulated terminals handling operations representative of typical use in supply holding or storage and marshaling areas. Terminals handling operations include storage, stacking, loading/unloading of semitrailers, trucks, and flatcars, and movement and storage of breakbulk cargo in soft sand and, if possible, soft mud areas. The terminals operations, procedures, and course layout are shown in figure 1. The test item is subjected to 5 hours of terminals operations.



PROCEDURE: After completion of the mobility test course, the test item is required to perform loading/unloading, stacking and storage operations as required in a forward storage area. The test item proceeds from the storage area to the previously mentioned areas of operation using the previously specified trails. Upon reaching each individual area, the test item lifts or picks up an item and returns it to the storage area where it will be stacked in the position specified by the test director. During the terminals handling test, the test item is required to stack empty containers three high and loaded containers two high, load flatcars, traverse longitudinal slopes of 25% and side slopes of at least 15%, and perform left and right turning and full circle maneuvers. (Unequal load distribution and stability are not evaluated during these operations but are evaluated during the technical performance phase (para 8.3c).) Upon completion of the terminals operations, the test item performs the retrograde operations as specified in paragraph 11.2c.

Figure 1. Terminals Handling Operations.

10.4 Data Required. Collected data include the data required by paragraph 9.4, observed ability of the forklift to engage and emplace containers and execute required maneuvers and positioning, degree of compatibility with the various transport media, relative performance over varied course conditions, and indicated durability in sustained operations.

10.5 Analytical Plan. Data are evaluated to assess the operational sufficiency of the item in typical terminals use, including capability of the forklift to satisfactorily perform and negotiate in a terminals environment without degradation of capability, malfunction, or damage.

11. Logistics-Over-the-Shore (LOTS). (NOTE: This test is typical for a container handling forklift in conjunction with marine landing craft. For other types of LOTS operations, such as those using mobile cranes, amphibians, air cushion vehicles, or helicopters, refer to such documents as 1-2-500, 1-2-510, and 9-2-251 for guidance.)

11.1 Objectives.

a. To evaluate the capability of the MHE to be transported by marine vessel and landing craft and to be discharged as cargo from ship to shore.

b. To determine the capability of the MHE to transfer cargo from marine to land carriers at the beach interface.

11.2 Methods. The following methods are used:

a. Fording Test. The test item is prepared for deep water fording as prescribed in the appropriate technical manuals. If the technical manuals do not contain instructions for fording, procedures recommended by the test agency are used and recorded. Once the test item has been inspected for deep water fording, it is subjected to a 60-inch fording test at Aberdeen Proving Ground. Using the fording basin (TOP 1-1-011), the test item, with the lifting attachment raised to the maximum height, is required to ford a water depth of 60 inches for a period of approximately 2 minutes. Upon exiting from the fording basin the test item is required to lift and carry an 8- by 8- by 20-foot loaded ISO/MILVAN (approximately 44,000 lb.) container over sand and abrasive mud courses for a combined distance of 3000 feet. This completes one fording cycle.

(If possible, the course traversals are conducted in conjunction with the beach mobility testing described in para 9.) The test item is subjected to five fording cycles. After each cycle the operator is questioned concerning maneuverability, turning, steering, stability, and braking. If deemed necessary, a braking test is performed after each fording operation to insure that the braking capability of the test item has not deteriorated. Upon completion of the specified fording cycles the test item is visually inspected for water, sand, or mud

contamination or seepage. Oil samples are obtained from the differentials, crankcase, transmission, wheel hubs, and hydraulic system to measure amounts of water contamination or seepage into these components. Inspection includes the removal of the wheel cylinder assembly, if necessary, to determine the presence of corrosion.

At the conclusion of the fording operations, a functional and operational check of the test item is conducted to insure that the fording operations have not affected the operational capability of the equipment.

An alternative fording test may be arranged on-site whereby the forklift is run in the surf parallel to the beach in required depths of water. By this method precise measurements of fording depths will not be obtained, but more realistic effects due to the use of sea water and varying water surface and floor conditions will be demonstrated.

b. Transfer Operations. The test item is prepared for deep water fording as prescribed in the appropriate technical manuals or as recommended by the test agency. It is then driven onto an LCM-8 or LCU, retrograded approximately 1/4 mile from the shore, and beached at locations selected by the test director to provide wet ramps of 36, 42, 54, and 60 inches of water depth (depths include wheel sinkage depth and wave height). During all embarkation and debarkation operations the landing craft ramp angles, vehicular angles of approach and departure, surf and sea conditions, and comments from observations of the ability of the item to be discharged as cargo for movement from ship to shore are determined and recorded. After all fording operations oil samples are obtained and analyzed.

c. Retrograde Operations. Once the mobility and terminals operations tests have been completed, the test item is required to retrograde containers from the storage area to the beach area. The test item transports an unloaded 20-foot MILVAN container from the storage area to the beach area. Upon arrival at the location of the landing craft, the test item fords through the surf and loads the container onto the vessel. When the test item returns to the storage area, one retrograde cycle is completed. Five cycles of the retrograde operations are conducted.

At the completion of every 3 hours of operations during the operational and mobility test cycles, oil samples are obtained from the differential, wheel hubs, engine, transmission, and hydraulic system to insure that there is no appreciable solid or water contamination introduced into these components.

During the LOTS phase of testing, the vehicles are left exposed to the salt-laden atmosphere in the vicinity of the beach at all times. During the entire period the test item is not washed or cleaned but is given a visual inspection at least every other day. During all operations, observations are made concerning the stability of the vehicle in

water, steering response, general characteristics of turning and maneuverability, mobility into and out of surf, driver operational visual fields, and potential safety hazards. At the conclusion of the LOTS tests, the test items are cleaned thoroughly and given a technical inspection. Any components of the test item which show evidence of corrosion are given a complete teardown and inspected to determine the extent of damage.

11.3 Data Required. The following data are required:

a. During fording operations, test personnel record comments on the ease of the test item entry into, fording, and exit from the fording basin. The amount of water seepage encountered during fording is measured or estimated; the type and amount of solid and water contamination in oil samples and the time and depth of vehicle submergence are measured and recorded; and comments are recorded on the ability of the test item to respond to operational readiness upon completion of the fording test.

b. During the LOTS operations, the environmental conditions, sea conditions, height of waves, windspeed and direction, loading and unloading operations, number of containers off loaded per hour, weight in pounds and type of load, vehicle performance while fording and negotiating sandy terrain, the amount of contamination encountered during fording operations, the effects of exposure to the salt-laden atmosphere, the ability of the test item to negotiate landing craft ramps, ramp angles, vehicle stability, description of soil, soil moisture content, terrain profile, soil index, soil trafficability, mobility index, and observations concerning safety of test personnel and equipment during testing are recorded. Ramp angles are measured to $\pm 1^{o}$. Difficulties encountered during loading/unloading and stacking operations, cycle times for terminals handling operations, drivers' fields of view and safety, maximum allowable slope in degrees of egress and ingress ($\pm 10\%$), type of terrain encountered, and vehicle fuel consumption are measured and recorded.

c. The length, width, height, and weight of the test item when prepared for shipment are measured and recorded. These data are compared with information on various marine vessels and landing craft.

d. All data collected are presented in narrative or tabular form, as appropriate.

11.4 Analytical Plan. Collected test data are analyzed to determine whether the test item is capable of movement as on-board cargo for LOTS operations and for transport by marine vessels and landing craft without weight or dimensional restrictions, and without sustaining damage, deformation, or malfunctioning of any component; and to determine the capability of the test item to satisfactorily perform and negotiate the test course depicted without degradation of the operational capability, malfunction, or damage during loading or unloading, storage, or stacking operations. If the test item is capable of successfully meeting these conditions, the test criteria will have been met.

12. Restraint System Tests. Internal cargo restraint systems may be wooden, mechanical, foamed-in-place, pneumatic, or other types. All serve to secure lading in containers against shifting and damage. Many aspects of testing restraint provisions are common regardless of type; some aspects, however, depend upon the specific system used. The following procedures should be reviewed for applicability depending on the particular restraint system to be tested.

12.1 Objective. To determine internal restraint system adequacy for restraining selected commodities against movement and damage and to obtain specific performance data.

12.2 Standards. As specified in the ROC, DP, or other requirements authority. The governing acceptance criterion is the ability of the system to protect cargo from damage during mission type exposures.

12.3 Method. The selected cargo is secured inside a container using the restraining system to be tested. Standard containers to which appropriate instrumentation has been added may be used, or a specifically instrumented test container (fig. 2) may be used. In either case, the cargo is loaded to the desired density/mix, palletized and banded, if necessary. Diagrammatic sketches are made showing the types and locations of instrumentation.

Instrumentation includes bridge-type strain gage transducers, strategically located on straps, tiedowns, and reference points on the container and the carrier, with multichannel recording or telemetry equipment. For vehicle transported phases, a fifth wheel speedometer may be used.

The secured and instrumented cargo-in-container is transported and handled in various intermodal transfer situations including, but not limited to, highway and rail transport and selected terminals handling operations. Simulation techniques are used to the extent practical. Also where practical, tests are incorporated and instrumentation is monitored in conjunction with actual operations, such as marine transfer or airlift.

a. Highway Transport. The container on its appropriate vehicular carrier is hauled at specified speeds and distances over selected vehicle test courses (TOP 2-2-506 or TOP 2-2-507). (For representative types of tests and mileages see TOP 10-2-214, para 26, or TOP 1-2-500, para 7 and table 2.)

b. Rail Transport. Care must be exercised in planning for tests; some may require cushioned frame or otherwise dampened, or undampened, railcars. Tests may be operational type (TOP 10-2-214, para 26) or rail impact (TOP 1-2-500, para 6).

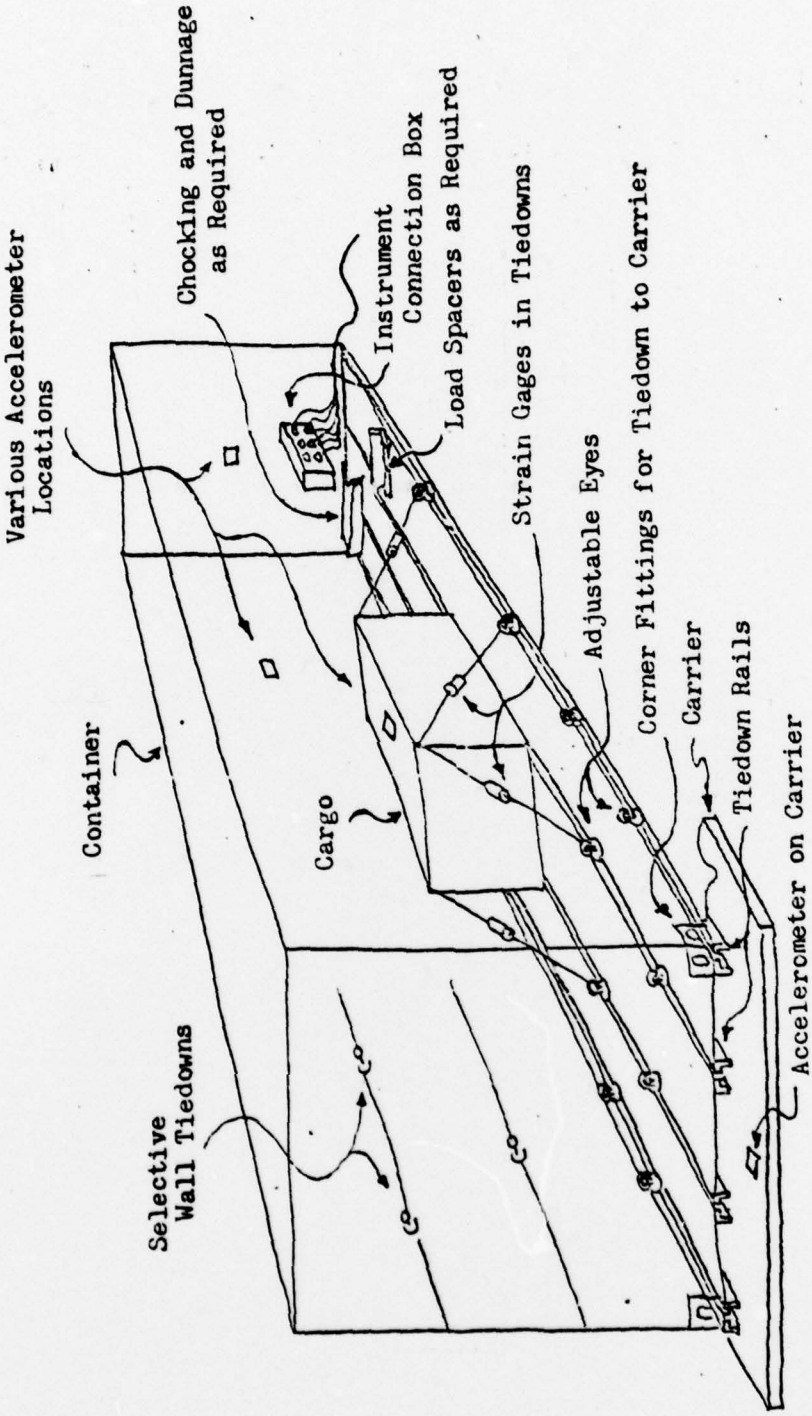


Figure 2. Instrumented Container.

c. Terminals Handling. During exposure to test conditions as described in paragraphs 9, 10, and 11 above, instrumentation of the restraint systems is monitored, and systems are inspected periodically.

d. Drop Tests. The container with appropriately restrained cargo is lifted and placed on blocks as shown in figure 3, depending on whether end, side, or cornerwise drops are intended. After instrumentation is connected, the retaining block is tripped, allowing the container to fall and impact the surface. Unless otherwise specified, drops will proceed at 2-inch intervals up to the maximum specified not to exceed 24 inches. Depending on requirements, the surface may be concrete or hard-packed earth. After each drop the container is opened, and the restraints and cargo are inspected for shifting and damage.

e. Tilt Tests. With cargo restrained, and with strain gage links in the restraining straps to determine tension, the container is attached to two lifting media that will enable the container to be tilted to specified angles. The container is tilted in 10-degree increments from the vertical until the final measurement between container wall and ground of 10 degrees. Tension on the restraining straps is recorded at each increment of tilt.

For tests of specific components of restraint systems, laboratory tests as prescribed in paragraph 6 of TOP 10-2-214 may be used, or tensile tests may be arranged on the tiedown facility (see para 13).

12.4 Data Required. Collected data include measurements of accelerations, impact forces, strap tensions (static or dynamic), degrees of shifting and damage to cargo; the occurrence, conditions, and effects of loosened restraints; indicated points of unacceptable stress, deformation, or failure; and comparative performance of different types of systems used.

12.5 Analytical Plan. Data are presented in tabular or narrative form, and are objectively compared with the stated requirements.

13. Spreader, Sling, and Pendant Tests.

13.1 Objective. To determine whether lifting devices and accessories are adequate for their intended services.

13.2 Standards. As specified in the ROC, DP, or other requirements authority.

13.3 Method. The specific spreader, sling, or pendant is evaluated for the scope of applicability for which it is intended. The types and configurations of containers or cargo to be lifted are obtained. The type of lifting gear (crane, helicopter, ship's gear, etc.) with which the lifting devices are to be used is arranged. Tests may be arranged using actual facilities, if available, or simulation facilities as indicated hereafter. Primary simulation facilities include the Tiedown Facility (fig. 4) and the Sling Facility (fig. 5).

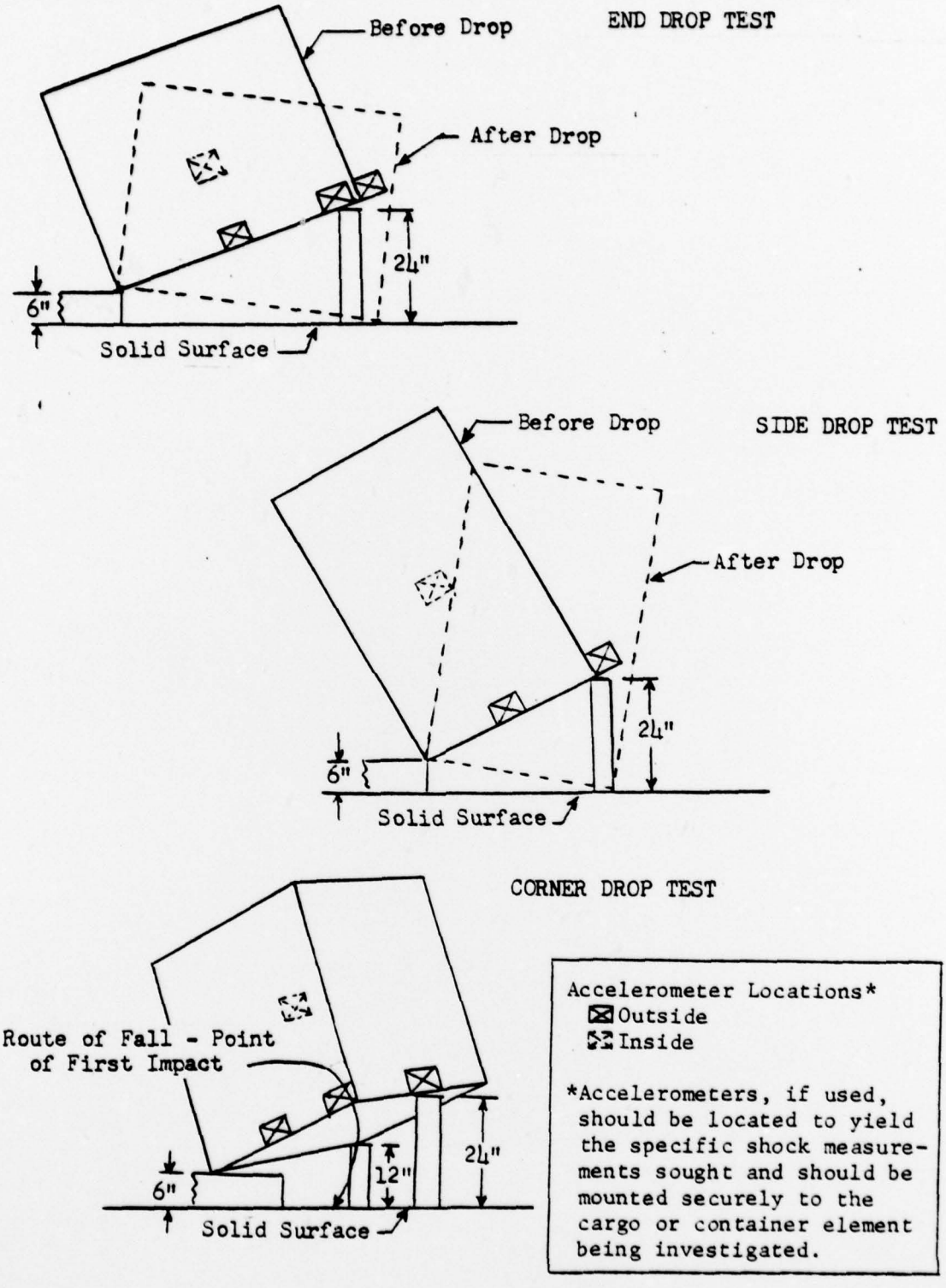


Figure 3. Drop Test for Containers (Restrained Cargo Inside).

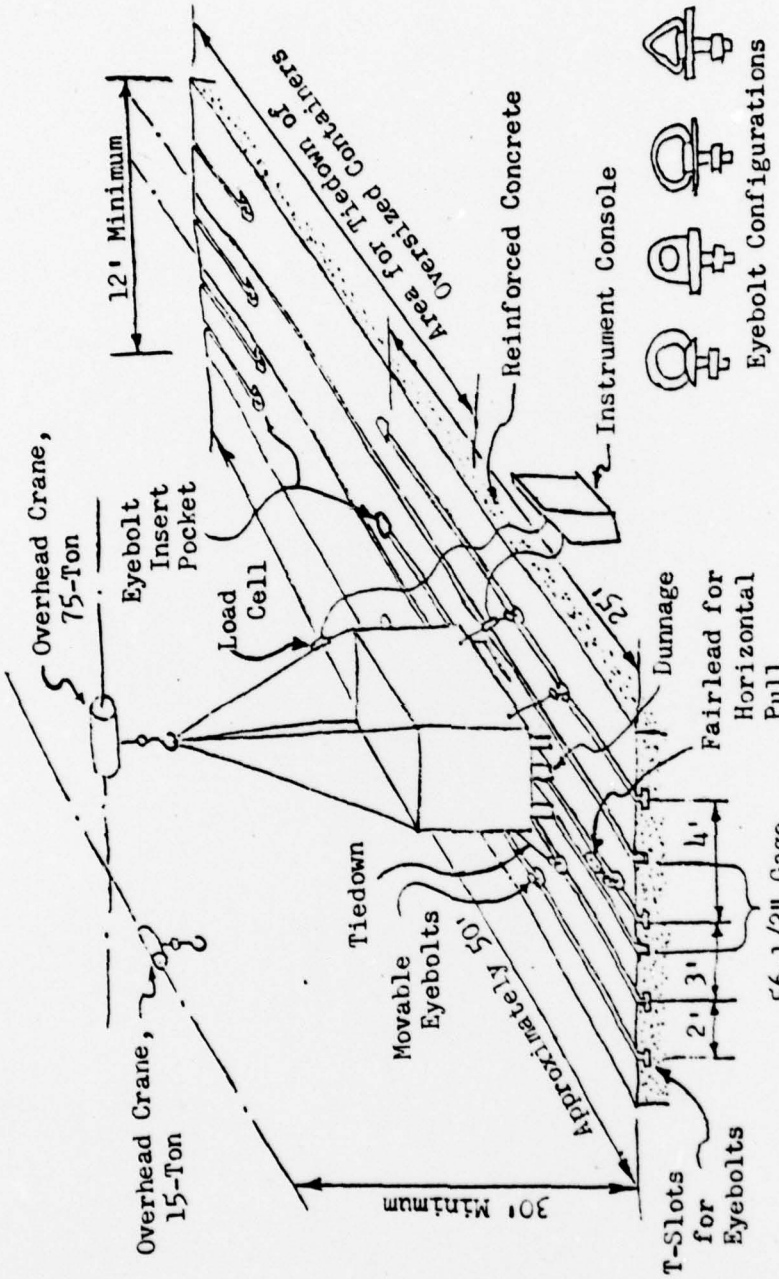


Figure 4. Tiedown Facility.

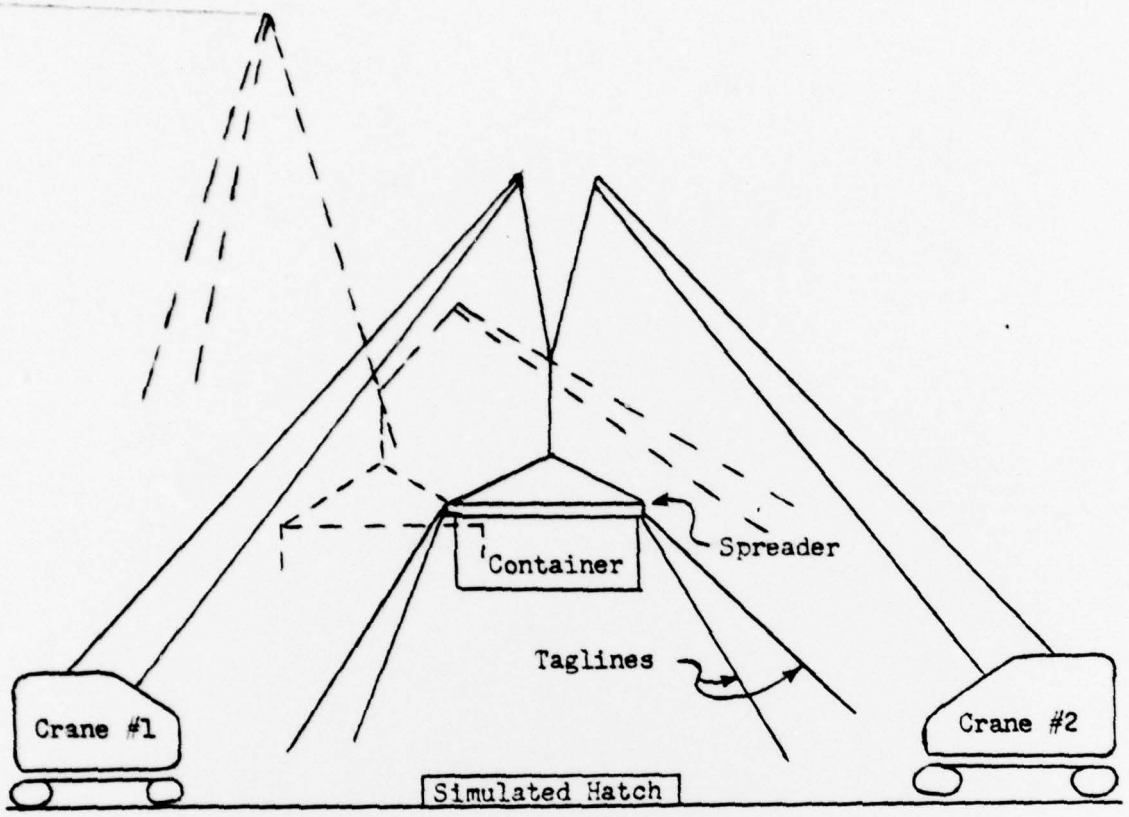


Figure 5. Sling Facility.

To determine compatibility, the lifting device is mated with the container, activating the hookups or engaging the fittings. Note is taken of any misalignment, chafing or interference of lifting gear with container structure, angle of sling legs, and apex height. Measurement instrumentation is attached to provide readout of tensile forces in sling legs, inertia loads in corner fittings, acceleration and deceleration forces, and impacts that may occur at ground or loading station contact.

With the container securely attached to the tiedown facility, the lifting device is subjected to static tensile force to the level indicated by requirements documents. Period and cycles of application of force are as specified. (See MIL-STD's -209 and -814 for guidance in calculating static forces.)

Dynamic testing is accomplished by using the lifting device in cyclic performance either with actual lifting facilities or the Sling Facility (fig. 5). A lifting cycle is arranged whereby the loaded container is attached, lifted to representative height, manipulated or

rotated by tagline or crane control, suspended for a specific period, spotted to the unloading point, monitored in performance through any aligning or motion dampening provisions, and returned by reverse lift to the initial pickup station. During lowering operations using normal lowering speeds, braking is quickly applied, and peak forces in slings and at critical strain gage locations are noted. The number of cycles is arranged in accordance with the specified durability or reliability requirements of the test devices.

13.4 Data Required. Data include description of the lifting device and the loads; number, types, and locations of end fittings, dimensions of slings or spreaders, description of applied motions or forces (extent, point of application, direction, etc.), lifting and lowering speeds, inertial forces, accelerations, impacts; observation of engagement/disengagement compatibility, extent of control and alignment, and occurrence of any deformation, malfunction, or inadequate performance.

13.5 Analytical Plan. Measurements and observations are evaluated against the criteria and intended functions of the lifting devices. Degree of conformance to requirements is determined and judgment is made as to adequacy of the equipment in performing its intended function.

Recommended changes to this publication should be forwarded to Commander, U. S. Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, Md. 21005. Technical information may be obtained from the preparing activity: Commander, Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md. 21005. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX
REFERENCES

1. AR 70-44, "DOD Engineering for Transportability."

2. AR 70-47, "Engineering for Transportability."

3. TECOM Suppl 1 to AR 750-1, "Maintenance Evaluation During Testing."

4. TECOM Pam 310-4, "Test Operations Procedures Consolidated Index."

5. TB 34-9-109, "Standardization of Fifth Wheel Attachments and Location and Height of Fifth Wheel Attachments on Tractors and Semitrailers."

6. TB 55-100, "Transportability Criteria, Shock and Vibration."

7. MIL-STD-209D, "Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment."

8. MIL-STD-448, "Test Methods for Construction and Industrial Machinery," Parts I and Ii.

9. MIL-STD-461A, Notice 4 (EL), "Electromagnetic Interference Characteristics, Requirements for Equipment, Subsystem, and System."

10. MIL-STD-462, Notice 3 (EL), "Electromagnetic Interference Characteristics, Measurement of."

11. MIL-STD-810B/C, "Environmental Test Methods."

12. MIL-STD-814A, "Requirement for Tiedown, Suspension and Extraction Provisions on Military Material for Airdrop."

13. MIL-STD-882, "System Safety Program for Systems and Associated Subsystems and Equipment, Requirements for."

14. MIL-STD-1472A, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities."

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